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Dengue vector surveillance in insular settlements of Pulau Ketam, Selangor, Malaysia

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Abstract. A year-long ovitrap surveillance was conducted between November 2007 and October 2008 in two insular settlements (Kampung Pulau Ketam and Kampung Sungai Lima) within the Malaysian island of Pulau Ketam. Eighty standard ovitraps were placed indoors and outdoors of randomly selected houses/locations. Results demonstrated an endemic baseline *Aedes* population throughout the year without weekly large fluctuations. Kampung Pulau Ketam has high *Aedes aegypti* and *Aedes albopictus* population, but only *Ae. aegypti* was found in Kampung Sungai Lima. *Aedes aegypti* showed no preference for ovitraps placed indoor versus outdoor. However, as expected, significantly more outdoor ovitraps were positive for *Ae. albopictus* ($p<0.05$). Trends in *Ae. albopictus* and *Ae. aegypti* populations mirrored each other suggesting that common factors influenced these two populations.

INTRODUCTION

Aedes aegypti is the primary vector of dengue, while *Aedes albopictus* is likely to be the more important vector of chikungunya (Reiter *et al*., 2006). Dengue is the fastest growing vector-borne disease in the world (WHO, 2008). Today, an estimated 3.46-3.61 billion people live in areas at risk of dengue from 124 countries which correspond to 53.0-55.0% of the world population (Beatty *et al*., 2007). Due to global warming *Ae. aegypti* amd *Ae. albopictus* may move northward and have more rapid metamorphosis, the WHO expects millions more will be affected in the coming years (Shope, 1991; TIME, 2007). In addition to dengue infection, Chikungunya is another *Aedes* mosquito-borne infection rapidly emerging in many Indian Ocean countries (Mourya & Yadav, 2006; WHO, 2006). In Malaysia, dengue and chikungunya infections are both transmitted by two species of *Aedes* mosquitoes, namely *Ae. aegypti* and *Ae. albopictus*. An improved understanding of *Aedes* population dynamics would lead to more effective vector control to combat dengue and chikungunya in Malaysia. The ovitrap surveillance in Barangay sta. Cruz, Malati city. The Philippines showed that the mean ovitrap index of 40% and the mean larval density is 5.32±5.30 for the period of 17 January 2005 to 3 February 2005 (Santiago, 2006). Chen *et al.* (2006) reported that more *Ae. aegypti* than *Ae. albopictus* were found during the ovitrap surveillance in four endemic areas (Taman Samudera, Kampung Banjar, Taman Lembah Maju and Kampung Baru) in Kuala Lumpur City Centre and Selangor State, Malaysia with 12.50% to 89.26% of ovitrap indices, but Rozilawati *et al.* (2007) found that Kampung Pasir Gebu and Taman

Permai Indah, Penang, Malaysia have high percentage of *Ae. albopictus* than *Ae. aegypti* with 66.00% to 99.00% of ovitrap indices. Although studies on the *Aedes* population dynamics have been conducted in Malaysia, similar study has not been reported from fishing village in an island. The present study reports findings of such study in fishing villages in Pulau Ketam, off the Port Klang in Selangor. Pulau Ketam is endemic for dengue as cases have been reported previously. A total of 2 cases were reported in 2003, 33 cases in 2005 and 12 cases in 2006. During the course of this present survey (November 2007 to October 2008), a total of 8 cases were reported (Ministry of Health, Malaysia, unpublished data).

MATERIALS & METHODS

Ovitrap Surveillance

The ovitrap surveillance was conducted adhering to the guidelines of the Ministry of Health, Malaysia (Tee *et al.*, 1997). A black plastic container of 300-ml volume with a base diameter 6.5 cm, opening diameter 7.8 cm and 9.0 cm in height was used as an ovitrap container. Hardboard measuring 10 cm x 2.5 cm x 0.3 cm was used as an oviposition paddle. The paddle was placed in the ovitrap container with the rough surface upwards and clean water was added to a level of 5.5 cm.

Eighty ovitraps (Figure 1 and 2) were placed indoor and outdoor in houses/ locations randomly selected using a Global Positioning System (GPS). Indoor refers to the interior of the house and outdoor is outside the building but still within the immediate vicinity of the house (Lee, 1991a). All traps were labeled and placed near potential breeding sites which were not flooded or exposed to direct sunlight. They were placed near adult resting sites such as dark corners, wall, vegetation etc. at or near ground level with minimum human or animal disturbances.

After 7 days, ovitraps were collected back and the contents were transferred into plastic containers (16cm x 11cm x 7 cm). Tetramine® powder (fish food) was provided as larval food. The hatched larvae were counted and identified at third or fourth instar under a compound microscope.

The ovitrap result was expressed as ovitrap index and larval density (no. larvae per trap) as follow:

Ovitrap Index (OI) = (Number of positive traps / Number of recovered traps) X 100%

Mean larvae per trap = Total number of larvae / Number of recovered ovitraps

Study Sites

Two townships in Pulau Ketam have been selected for the ovitrap surveillance, *viz.* Kampung Pulau Ketam and Kampung Sungai Lima. Kampung Pulau Ketam has a population of 9,150 while the population of Sungai Lima is 1,540. Both townships are fishing villages. Most of the buildings are single and double storey terraced houses built with wood and cement. The buidings are situated atop the sea with poor drainage system and scattered vegetation. These two townships are separated from each other by at least 2.0 km of mangrove forests and could therefore be considered as insular sites.

The rainfall and temperature data were obtained from the Meteorology Department of Malaysia. Independent t test was used to test the distribution of both *Ae. aegypti* and *Ae. albopictus* based on ovitrapping data at p=0.05 (SPSS v10).

RESULTS

The ovitrap index and larval density of *Ae. aegypti* and *Ae. albopictus* was as shown in Figure 3 and Fugure 4. The highest ovitrap index of *Ae. aegypti* in Kampung Pulau Ketam was 63.0%, while in Kampung Sungai Lima; the highest index was 80.0%. High *Ae. albopictus* population was found in Kampung Pulau Ketam. However, ovitrap index was found very low in Kampung Sungai Lima (4 positive out of 450 traps). Hence the presence of *Ae. albopictus* in Kampung Sungai Lima was considered

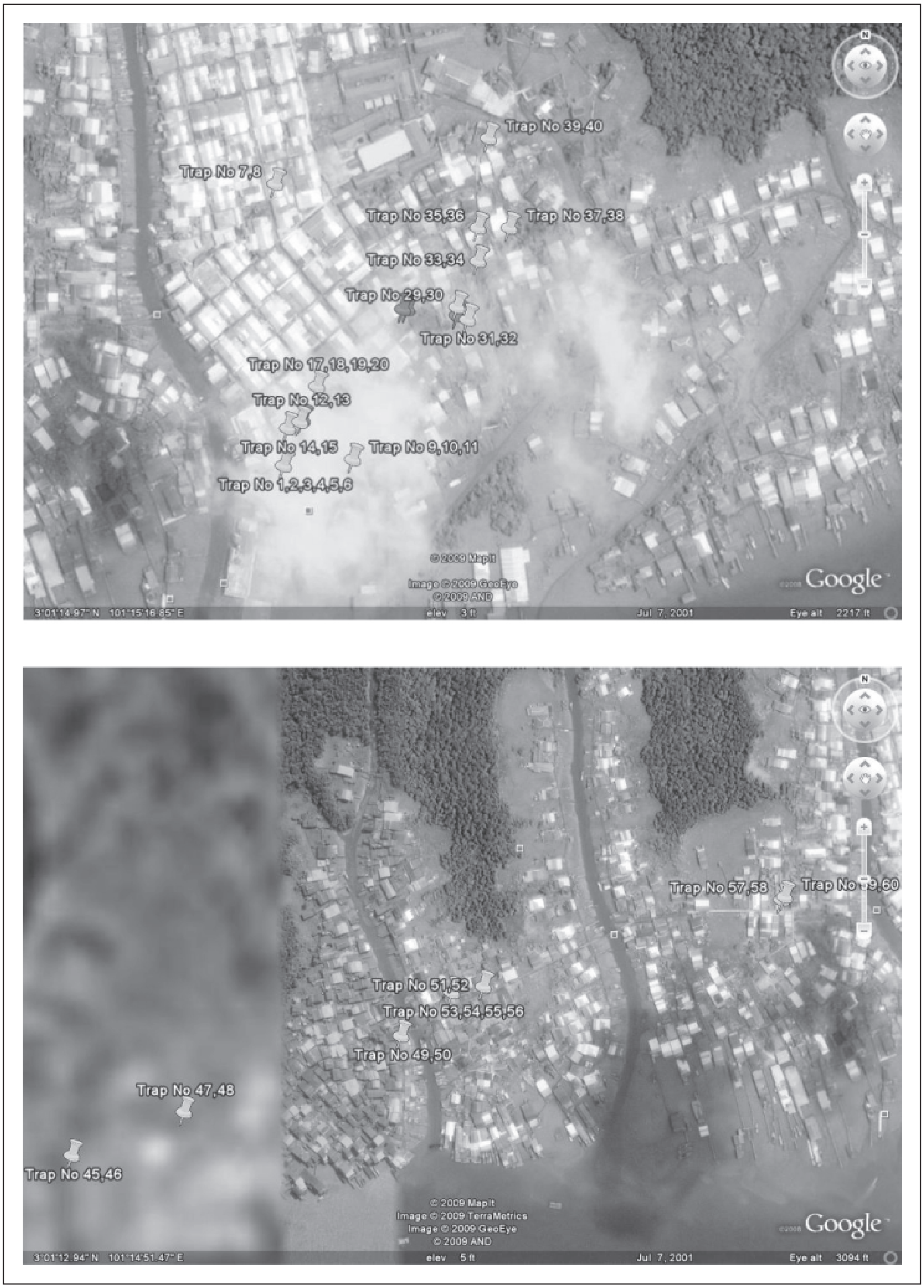

Figure 1. Location of ovitraps set in Kampung Pulau Ketam, Pulau Ketam. (A): Trap no 1-40; (B): Trap no 41-60

Figure 2. Location of ovitraps set in Kampung Sungai Lima, Pulau Ketam

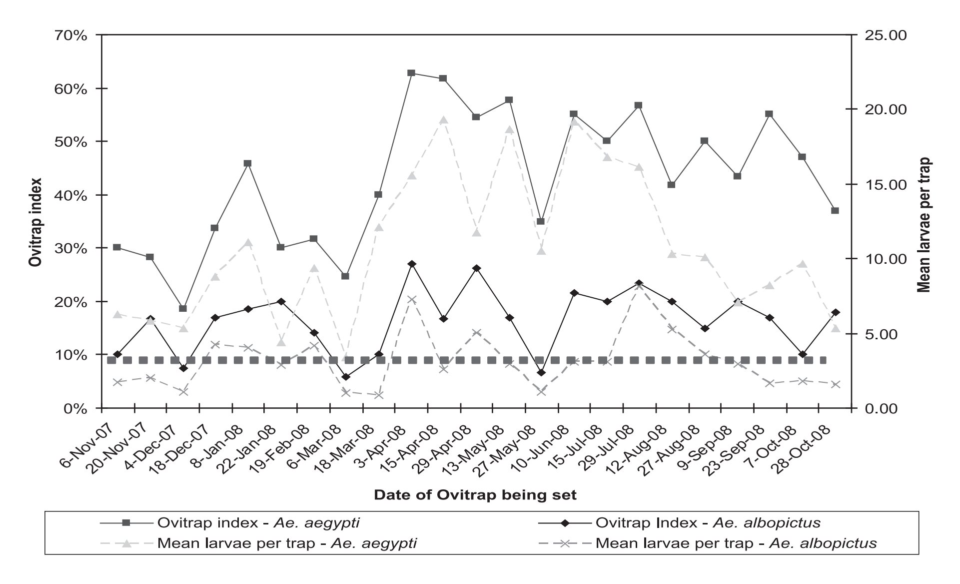

Figure 3. Ovitrap index and mean larvae per trap of *Ae. aegypti* and *Ae. albopictus* Kampung Pulau Ketam

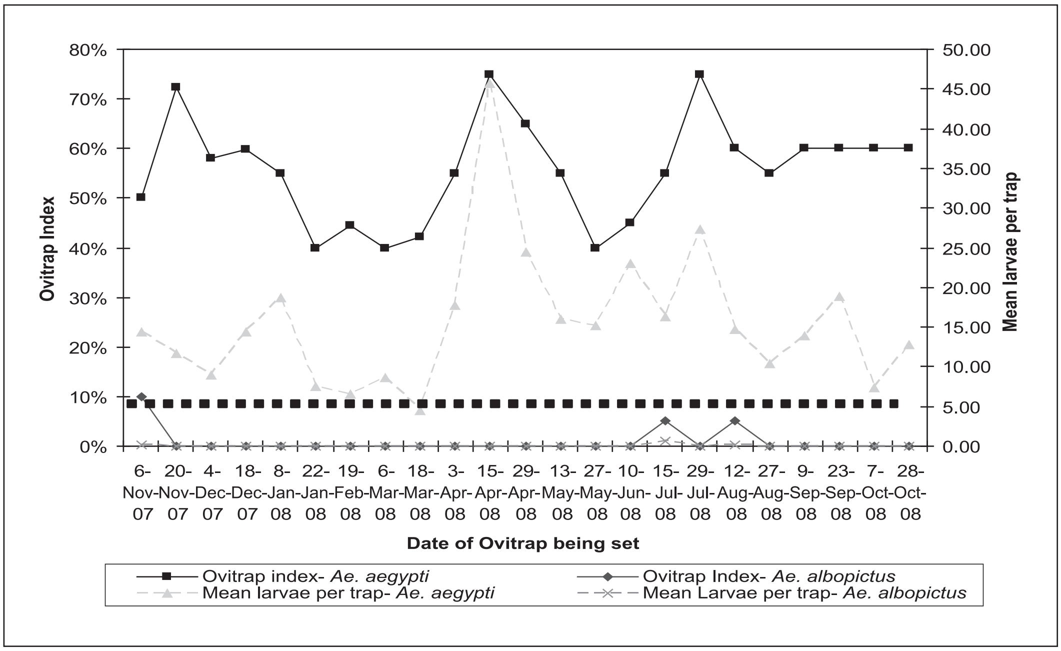

Figure 4. Ovitrap index and mean larvae per trap of *Ae. aegypti* and *Ae. albopictus* Kampung Sungai Lima

negligible. Results revealed that *Ae. aegypti* is the predominant *Aedes* species in both settlements of the island ($p>0.05$).

Although the mean outdoor OI (22.0%) was significantly higher than indoor OI (10.0%) for *Ae. albopictus* in Kampung Pulau Ketam ($p<0.05$), there was no significant preference in the selection of ovipositing between indoor or outdoor ovitraps by *Ae. aegypti* in both Kampung Pulau Ketam and Kampung Sungai Lima (Figure 5 and Figure 6) ($p>0.05$).

DISCUSSION

The mean larvae per trap of *Ae. aegypti* and *Ae. albopictus* in Kampung Pulau Ketam (10.65±4.88 larvae per trap and 3.14±1.93 larvae per trap) was similar to the survey by Chen *et al.* (2006) in Kampung Banjar, Gombak, Selangor. Kampung Banjar is a low-income settlement with more than 200 wood and cement houses. Kampung Banjar is quite similar to Kampung Pulau Ketam in terms of poor drainage system, discarded rubbish and scattered vegetation; the mean larvae per trap of *Ae. aegypti* in Kampung Banjar was 10.13±3.36 larvae per trap and for *Ae. albopictus* 2.04±1.38 larvae per trap.

Aedes aegypti is dominant in both Kampung Pulau Ketam and Kampung Sungai Lima. This was similarly reported by Chen *et al.* (2006) and Lee (1991a) in surveys done in Selangor State in which *Ae. aegypti* was found in higher frequency than *Ae. albopictus* in ovitrap. Macdonald (1956) reported that *Ae. aegypti* had been introduced into Malaya through the seaports and coastal areas at the beginning of 20th century and by 1913 it has replaced *Ae. albopictus* as the most common *Aedes* species. According to an IMR conducted survey in 1902 (Macdonald, 1956), *Ae. aegypti* was only found in Port Swettenham (currently known as Port Klang); indicating that this mosquito was introduced via this seaport in the early days. As Pulau Ketam is located close to Port Klang, it is possible that *Ae. aegypti* had spread to and remained established in Pulau Ketam till today.

In Malaysia, *Ae. aegypti* is a domestic species found in or around houses because

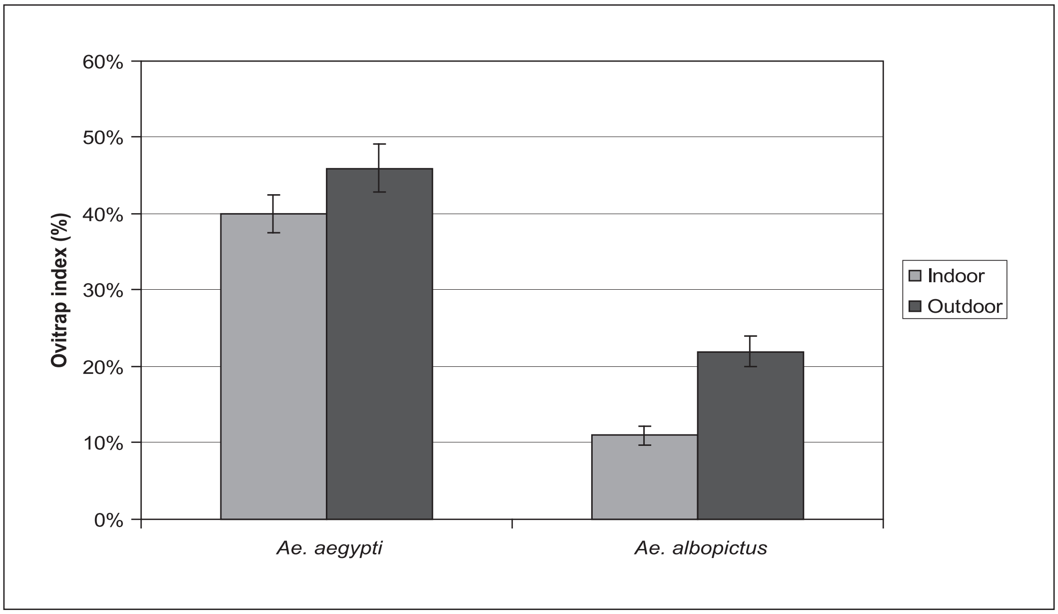

Figure 5. Ovitrap index of indoor and outdoor placement in Kampung Pulau Ketam. Error bar = Standard Error Mean (SEM)

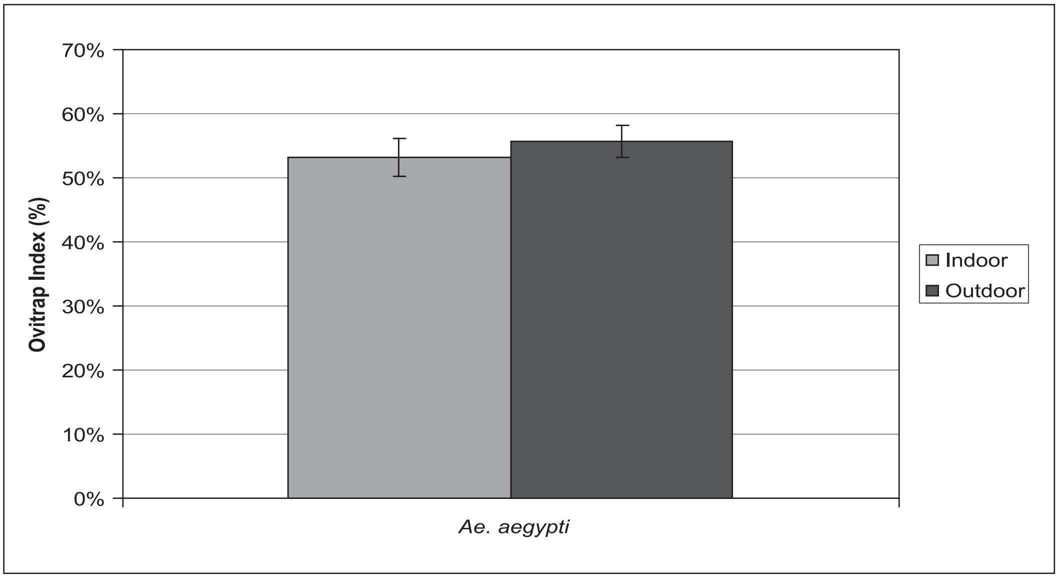

Figure 6. Ovitrap index of indoor and outdoor placement in Kampung Sungai Lima. Error bar = Standard Error Mean (SEM)

of its dependence on human for its blood meal and its forefathers are thought to have originated from the coastal house-frequenting forms in east Africa (Cheong, 1987). The environment of Pulau Ketam which comprised of many houses with high human population provided suitable habitats for *Ae. aegypti*. The houses in Kampung Pulau Ketam and Kampung Sungai Lima are typically dark and damp which provide potential resting places for *Ae. aegypti*. Large numbers of adult *Ae. aegypti* were also found on clothing, furniture and other articles in dark and damp houses in Singapore (Chan, 1981).

The low population of *Ae. albopictus* in Kampung Sungai Lima could possibly be due to the geographically isolated location of the village. This insular site is only accessible via sea route thus the possibility of introduction of *Ae. albopictus* is minimised. It is also likely that historically, the area has long being dominated by *Ae. aegypti* which was introduced and established more than 100 years ago.

Aedes albopictus was only found in Kampung Pulau Ketam and not in Kampung Sungai Lima possibly because *Aedes* mosquitoes increased their numbers by colonization of available sites rather than into previously uninfested areas (Stickman & Kittayapong, 2002). *Aedes albopictus* has a preference for forest-fringe habitats and disturbed, well-vegetated habitats with trees (Rudnick *et al.*, 1986). However, both villages in Pulau Ketam have less vegetation which could possibly explain of the low population of *Ae. albopictus*. Trends in *Ae. albopictus* and *Ae. aegypti* populations mirrored each other in this study, suggesting that common factors influenced these two populations.

In this study the ovitrap index of both indoor and outdoor containers was comparable. Lee (1990) reported that *Ae. aegypti* showed equal preference for both indoor and outdoor containers in several suburban communities in Selangor. A changing pattern in the breeding of *Ae. aegypti* may be emerging in Pulau Ketam. Although nation-wide larval survey in 170 urban towns of peninsular Malaysia in 1988 to 1989 showed that *Ae. aegypti* preferred indoor containers, *Ae. aegypti* also showed equal preference to outdoor containers as *Ae. albopictus*. It thus appeared that there may be interspecies competition in outdoor breeding sites wherein *Ae. aegypti* was beginning to edge out *Ae. albopictus* (Lee, 1991b).

The breeding sites of *Ae. albopictus* are not only around and near houses, but also in the forests and plantations. Unlike *Ae. aegypti* which bites and rests indoors, *Ae. albopictus* bites both outdoors and indoors and rests mainly outdoor (Cheong, 1967). This may explain the preference of *Ae. albopictus* to breed outdoors compared to indoors.

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